## *SOCIETIES AND ACADEMIES.*

### London.

**Royal Society,** May 2.—"On the Spectrum, Visible and Photographic, of the Great Nebula in Orion." By William Huggins, D.C.L., LL.D., F.R.S., and Mrs. Huggins.

I have added the name of Mrs. Huggins to the title of the paper, because she has not only assisted generally in the work, but has repeated independently the delicate observations made by eye.

In the year 1882 I had the honour to lay before the Royal Society a note on the photographic spectrum of this nebula, in which I described a new bright line in the ultra-violet, to which I gave a wave-length of about 3730. In addition to this new line, the lines of hydrogen, H$\beta$ and H$\gamma$, which I had discovered by eye in my early observations on the visible spectrum, were to be seen upon the plate.

On account of the faintness of the object the slit had been placed rather wide, and for this reason the character of the line and its position, as I stated in the paper, could not be ascertained with the accuracy which I desired.

On February 5, 1888, a photograph of the spectrum of this nebula was obtained with a narrow slit; the same apparatus, so far as the essential parts, which were described in my paper, on the "Photographic Spectra of the Stars" (Phil. Trans., 1880, p. 672) being employed.

In this photograph, in addition to the strong line about λ 3730, a pair of less conspicuous lines is seen on the less refrangible side of the strong line.

The continuous spectra due to the two of the four bright stars of the Trapezium which fell upon the slit are present.

Across these continuous spectra at least four groups of bright lines can be seen, of which the greater number can be traced into the nebula for some little distance from the stellar spectra.

It is scarcely necessary to state the importance of this observation as showing that these stars of the Trapezium are not merely optically connected with the nebula, but are physically bound up with it, and are very probably condensed out of the gaseous matter of the nebula. This observation would seem also to show that the nebula, as a whole, may not be at a distance from us greater than that which we should attribute to such stars, if they occurred alone in the heavens.

The first group, of six lines, occurs between λ 4116 and 4167. The lines of this group do not extend far from the continuous star spectra, with the exception of two lines. These can be seen faintly in another photograph taken in 1889. Beyond there is a fainter group, probably of four lines a little beyond *h*. I am pretty sure that these lines extend into the nebula. The third group from λ 3896 to 3825, of which I have endeavoured to measure ten lines, is faint, but here there is no doubt that the same lines are present in the adjoining nebular matter. There are two lines a little more refrangible than the strong line seen in 1882, at about λ 3709 and λ 3699. I have a suspicion of a faint group about this place, and also of another group on the less refrangible side of G.

I shall discuss further on, the probable chemical significance of these lines.

During the time that Orion was favourably situated for observation in the season of 1888 and in that of the present year, the unusual continuance of bad weather made it impossible for me to give so complete an account of the spectrum of the nebula in the photographic region as a few really fine nights would have enabled me to do. However, on February 28 of the present year I obtained another photograph, the slit being very narrow, which gives some more new information of the nature of its spectrum. I was astonished on looking at the photograph not to see the strong line about λ 3730, which was by far the most conspicuous feature of the photograph taken in 1888. The pair of lines near it on the less refrangible side, which I found for the first time in 1888, are present; and on a further scrutiny of the plate I discovered two other pairs of lines, most probably rhythmically connected with them, in the still more refrangible region, the last pair, accompanied by a third line, being near the ultra-violet limit of ex-terrestrial light.

I was also able to see faintly two of the bright lines which I have described as present across the continuous spectra of the brighter stars of the Trapezium in my photograph of 1888. It is not quite certain whether these very faint and short lines are really due to the matter of the nebula proper, or have come upon the plate in consequence of the stars of the Trapezium having fallen accidentally upon the slit for a time too short to impress the continuous part of their spectra. No trace of a continuous spectrum can be seen upon the plate, but these lines in the plate of 1888 do extend beyond the continuous spectra of the stars of the Trapezium.

I regret extremely that bad weather has made it impossible for me to work out the circumstances on which depended the disappearance of the strong line about λ 3730. Both the photographs which show this line include two stars of the Trapezium, and it may possibly be that this strong line is associated with the groups near it in the spectra of the stars, and may therefore come out in those parts of the nebula only which are more condensed. A few photographs with the slit differently placed upon the nebula would doubtless have thrown light upon this point. The suggestion presents itself strongly that the mottled and broken-up character of the nebular matter, shown in Lord Rosse's drawing from eye observations, and much more strikingly brought out in the recent photographs of Mr. Common and Mr. Roberts, may be connected with differences of spectrum in the photographic region, though in the visible region there is no known alteration of the spectrum of the four bright lines, except, it may be, some small differences of relative brilliancy of the lines.

Until next winter we cannot go beyond the new information which these photographs give to us. On the plate of the photograph of 1889 two pairs of spectra for comparison were taken: two spectra, one above and one below the nebular spectrum, of burning magnesium; and two spectra, similarly placed, of the light of the sky.

From the photographs of 1888 taken with a narrow slit, the position which I gave in 1882 to this line is shown to be, as I expected from the wide slit then used, approximate only. I find from the later photograph that the wide slit had caused the strong line to unite with a line near it, and that in 1882 I measured the middle of the broad band produced by the union of the wide images of two lines. Its position is about six tenth-metres more refrangible. It does not therefore agree, as I then suggested, with the hydrogen line ζ in my spectra of white stars. A statement of the position of this line relatively to the magnesium-flame triplet will be given further on, when I come to discuss the comparison of this spectrum with that of the nebula.

The position of the pair of lines a little less refrangible than this strong line, seen with it in the photograph of 1888, and present without the strong line in the photograph of 1889; and the positions of the two other more refrangible pairs, presumably connected with the first pair, are given in the following table:—

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|---|---|
| 1st pair about . . . . . . . . . . . | λ 3752·0 |
| | 3741·0 |
| 2nd pair about . . . . . . . . . . . | 3285·0 |
| | 3275·0 |
| Line at about . . . . . . . . . . . | 3060·0 |
| 3rd pair about . . . . . . . . . . . | 3053·0 |
| | 3047·0 |

In both photographs I suspect the indications of other lines, which are too faint to permit any certain conclusion to be formed about them, whether they are true lines, or imperfections only of the film.

[The continuous spectra of the stars of the Trapezium can be seen on the plate from about F to about λ 3570, but they are very faint beyond λ 3560.—*May* 18.]

#### *The Visible Spectrum.*

*a. Brightest line.*—In 1872 ("On the Spectrum of the Great Nebula in Orion, &c.," Roy. Soc. Proc., vol. xx. (1872) p. 383), I stated, as the result of numerous direct comparisons of this line with the brightest line in the spectrum of nitrogen, that the nebular line was "sensibly coincident with the middle of the less refrangible line of the double line of nitrogen." To avoid repetition I will call this line $N_1$. Except where it is otherwise stated, I use this line of nitrogen simply as a fiducial point in the spectrum, without any reference to its chemical significance.

In a still more critical examination of the position of the nebular line for the purpose of determining whether there was any indication of relative motions of the gaseous nebulæ in the line of sight, I found some experimental difficulty from the circumstance that the nebular line is narrow and defined, while $N_1$ is nebulous. I was fortunate to find a more suitable fiducial line of comparison in a narrow line of lead, which falls almost upon the middle of $N_1$ ("On the Motions of some of the Nebulæ towards or from the Earth," Roy. Soc. Proc., vol. xxii. (1874) p. 252). In December 1872, I compared this line directly with $N_1$, and found it sufficiently near in position to serve as a fiducial line of comparison.

Six other gaseous nebulæ were also examined, each on several nights, with the result that "in no instance was any change of relative position of the nebular line and the lead line detected" (*ibid.*, p. 253).

In the simultaneous observation of the nebular line and the lead line, it was found if the lead line was made rather less bright than the line of the nebula, the small excess of apparent breadth of this latter line appeared to overlap the lead line to a very small amount on its less refrangible side, so that the more refrangible sides of the two lines appeared to be in a straight line across the spectrum. The clearness of position of the two lines was shown by the observation that when the line of the nebula passed across the field of the spectroscope, and the lead line was thrown in, the lead line was not seen, but only an increase in brightness of the nebular line. By comparing the end of the nebular line near the Trapezium where it is refined to a point, I estimated that the difference of position of the middle of the lead line and that of the nebular line might be possibly from λ 0000·2 to λ 0000·3 (*ibid.*, p. 252). Some recent measures of the position of the lead line with the middle of $N_1$ show that the lead line is about λ 0000·12 more refrangible.

These direct comparisons of the nebular line with the lead line confirmed, therefore, my former conclusion, that the brightest line in the gaseous nebulæ is very near $N_1$, when seen under a dispersion equal to nearly eight prisms of 60, namely 36° 25′ from A to H.

This result is based on direct comparisons, on twenty-four different nights, with $N_1$ or with the line of lead.

The wave-length of $N_1$ has been determined by Kirchhoff, Thalén, and by myself. Watts's reduction of my measure to wave-lengths is clearly not accordant with my measures of air lines immediately preceding and following this line. I have therefore reduced my original measure to wave-lengths, and find for $N_1$ the value λ 5004·5.

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|---|---|
| Kirchhoff ... ... ... ... ... ... ... | 5004·6 |
| Thalén... ... ... ... ... ... ... ... | 5005·1 |

Thalén's value is clearly too high, as Thalén gives for the lead line, coincident nearly with $N_1$, λ 5004·6, and $N_1$ is seen on the more refrangible side of the solar iron line given by Ångström as λ 5004·9. In Ångström's map $N_1$ is laid down on the more refrangible side of the iron line 5004·9, at about 5004·5. The same position is given to $N_1$ in Kirchhoff's map.

I have made a new determination of the position of $N_1$, using the second spectrum of a grating 17,300 to the inch, relatively to the solar iron line at 5004·9 according to Ångström.

The value came out λ 5004·6, which agrees with Kirchhoff's value, and with Thalén's measure of the lead line which falls upon it, and also with the maps of Ångström and of Kirchhoff.

The wave-length of the brightest nebular line may therefore be taken at from

λ 5004·6 to λ 5004·8 . . . . . . . . . (1)

The micrometric measures of this line, given by D'Arrest, Vogel, and Copeland, agree closely with this value.

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| D'Arrest's[1] mean value ... ... ... ... | 5004 |
| Vogel's ,, ... ... ... ... ... ... | 5004 |
| Copeland's[2] ,, ... ... ... .. ... | 5004 |

*b. Second line.*—In 1872 (Roy. Soc. Proc., vol. xx., 1872, p. 385), I stated that I had found this line, by comparison with a line of barium, and subsequently with an iron line, to have

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|---|---|---|
| A wave-length of ... ... ... ... ... ... | λ 4957·0 | . . (2) |
| D'Arrest's mean value from micrometric measures ... ... ... .. ... | λ 4956·6 | |
| Copeland's mean value from micrometric measures ... ... ... ... ... | 4958·0 | |

*c. Third line.*—In my original paper (Phil. Trans., 1864, p. 437), "On the Spectra of some of the Nebulæ," in 1864, I showed, by direct comparison with hydrogen, that this line is undoubtedly the line of that gas at F of the solar spectrum. This observation was afterwards repeated (Phil. Trans., 1868, p. 545), and has been confirmed by the photographs of 1882 and 1888.

| | | |
|---|---|---|
| The wave-length of this line is therefore | λ 4860·7 | . . (3) |
| D'Arrest's value from measures ... ... | 4860·6 | |
| Copeland's ,, ,, ... ... | 4861·0 | |

*d. Fourth line.*—In 1872 (Roy. Soc. Proc., vol. xx., 1872, p. 385) I stated that I had satisfied myself of the coincidence of this line with H$\gamma$, but, on account of its faintness, it is very satisfactory to find this observation of coincidence confirmed by the photographs taken in 1888 and 1889. There can be no doubt that this is a line of hydrogen, and that

| | | |
|---|---|---|
| The wave-length therefore is ... ... ... | 4340·1 | . . (4) |
| Copeland's mean value ... .. ... ... | 4342·0 | |

Dr. Copeland gives the measures of two still fainter lines which he has seen in this nebula—namely, one at λ 5874, possibly coincident with $D_3$, and a line at λ 4476 (see also Mr. Taylor, *Monthly Notices R.A.S.*, vol. xlix. p. 125). I defer the consideration of these and other faint lines which I have often suspected in the faint continuous spectrum of the nebula, as in consequence of the great strain upon the eyes from my recent direct comparison of the spectrum of the nebula with the spectrum of burning magnesium, I was not able, during the very few fine nights when Orion was favourably situated, to undertake an examination for these very faint lines.

### *Comparisons with the Magnesium-flame Spectrum.*

In 1882, Dr. Copeland, in his paper on Schmidt's Nova Cygni (*Copernicus*, vol. i. p. 109), remarked in a foot-note, "that it is worthy of note that this line (λ 5006·5 of burning magnesium) almost absolutely coincides with the brightest line in the planetary nebulæ."

This line—namely, the bright edge of the first band in the magnesium-flame spectrum—is very near in position to the brightest nebular line. We have seen that the wave-length of this line in the nebulæ (1) is 5004·6 to 5004·8; now the wave-length of the end of the magnesium-flame band is 5006·5, consequently it does not coincide with the nebular line, but falls on the less refrangible side at a distance of λ 0002 nearly from that line.

The wave-length of the termination of the magnesium-flame band is, as determined by—

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| Lecoq de Boisbaudran ... ... ... ... ... | 5006·0 |
| Watts ... ... ... ... ... ... ... ... ... | 5006·5 |
| Liveing and Dewar[1] ... ... ... ... ... | 5006·4 |

I have recently determined the position of the end of the band, by direct comparison with the solar iron line given by Ångström at λ 5006·58.

My result places the magnesium-flame band line at λ 5006·5 . . . . . . . . . . . . . . . . . . (5)

In a paper read before the Royal Society in 1887,[2] Mr. Lockyer says:—"Only seven lines in all have been recorded up to the present in the spectra of nebulæ, three of which coincide with lines in the spectrum of hydrogen, and three correspond to lines in magnesium. The magnesium lines represented are the ultra-violet low temperature line at 373, the line at 470, and the remnant of the magnesium fluting at 500, the brightest part of the spectrum at the temperature of the bunsen burner." At p. 137 (*loc. cit.*) Mr. Lockyer says:—"In the nebulæ we deal chiefly with lines seen in the spectrum of magnesium at the lowest temperature."

In a later paper in 1888 ("Suggestions on the Classification of the various Species of Heavenly Bodies," Roy. Soc. Proc., vol. xliv. p. 21) Mr. Lockyer states:—"In a paper communicated to the Royal Society on November 15, 1887, I showed that the nebulæ are composed of sparse meteorites, the collisions of which bring about a rise of temperature sufficient to render luminous one of their chief constituents—magnesium. This conclusion was arrived at from the facts that the chief nebular lines are coincident in position with the fluting and lines visible in the bunsen burner when magnesium is introduced, and that the fluting is far brighter at that temperature than almost any other spectral line or fluting of any element whatever."

Although the number of direct comparisons which I had made of the brightest line in the nebulæ with $N_1$ and with the lead line, not to speak of the accordant results of the micrometric measures of other observers, left little doubt in my mind that this line could not be coincident with "the remnant of the magnesium fluting at 500," really at 5006·5, yet I thought it desirable to undertake the laborious task of comparing, with the necessary care and precautions, the nebular line directly, in the spectroscope attached to the telescope, with the spectrum of burning magnesium.

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[1] "Undersögelser over de nebulose Stjerner" (Copenhagen, 1872, p. 23).

[2] *Monthly Notices R.A.S.*, vol. xlviii. p. 361.

[1] Roy. Soc. Proc., vol. xliv., 1888, p. 245.

[2] "Researches on the Spectra of Meteorites: a Report to the Solar Physics Committee." Communicated to the Royal Society at the request of the Committee. Roy. Soc. Proc., vol. xliii. p. 118.

Arrangements were made by which the light from burning magnesium was thrown into the telescope from the side and then reflected down, under conditions similar with the light from the nebula, upon the slit of the spectroscope. By this arrangement any flexure in the tube connecting the spectroscope with the telescope would affect both spectra alike. The coincidence in position of the spectrum from burning magnesium with that of a heavenly body to which the telescope was so directed that its light fell upon the slit of the spectroscope, was tested with great care on several occasions by comparing the three bright lines of magnesium with the corresponding lines, $b_1$, $b_2$, $b_4$, in the spectrum of the moon. Indeed, to prevent any possible error in the observation of apparent want of coincidence of the nebular line, if the light from the burning magnesium should by an accident so come upon the slit as to bring its spectrum in a very minute degree on the less refrangible side of its true position relatively to the nebular line to be observed with it, the arrangement was purposely made that the lines of magnesium were seen to fall upon the corresponding dark lines at *b* in the moon, a very little on the more refrangible side of the middle of those lines. This state of things would diminish a little the interval which should be seen between the nebular line and the edge of the magnesium-flame band, and so make the determination more difficult; but if under such circumstances the nebular line was seen on the more refrangible side of that of magnesium, the observation would be much more trustworthy, for in the case of coincidence with magnesium the line would have appeared towards the opposite and less refrangible side of the magnesium line, broadening the magnesium line on this side. I considered that the comparison could be made most satisfactorily by the complete superposition of the two spectra, that from burning magnesium being gradually reduced in brightness by the interposition of coloured glass screens, until the ground of the spectrum between the successive bright lines of the band of the magnesium-flame spectrum was sufficiently subdued to allow of the nebular line being seen upon it.

Under these circumstances, if the nebular line had the position which my direct comparisons and the micrometric observations of other observers assign to it, it would be seen as a bright line at a very small interval within the line ending the band, and to the observer the band would appear to commence with a double line.

This direct comparison was first successfully made on March 6, 1889. The observations were made with the 15″ refractor belonging to the Royal Society. The spectroscope used has two compound Grubb prisms, each with 5 square inches of base, and giving nearly twice the dispersion of a single prism of 60°, namely, 9° 20′ from A to H; and collimator and telescope of 1·25-inch aperture. An eye-piece magnifying eighteen times was employed. The nebular line was brought upon the cross-wires, and when carefully focussed and clearly seen, the light from burning magnesium was thrown in. This observation is one of great difficulty, especially as the interval to be observed had been purposely reduced by causing the magnesium to fall, for the sake of the greater trustworthiness of the observations, on the more refrangible side of its true position. Although I consider the results to be satisfactory, I prefer to say that I, and Mrs. Huggins independently, believed fully at the time that we saw the appearance which all former observations of this line led me to expect—namely, the nebular line to fall within the termination of the magnesium band, and to form with the band-boundary a double line. The relative positions of the two spectra are represented in diagram across the page. The line at the end of the magnesium band was then brought upon the cross-wires, without any attention being given in the nebular line; when the burning magnesium went out, the nebular line was seen to be at a measurable distance to the left of the intersection of the wires—namely, on the more refrangible side.

When the object glass of the telescope was covered, the magnesium band presented its usual appearance—namely, terminating in a single line. These comparisons were repeated and confirmed generally on March 9, March 11, and March 16. On March 9 a single successful comparison was made with a more powerful spectroscope, giving a dispersion equal to nearly eight prisms of 60°. [Comparisons have been made since with the planetary nebula in Hydra. The short line of the nebula was found to fall within the termination of the magnesium band at about the small distance which corresponds to the known position of the two lines.—*April* 26.] On all these nights the comparisons were repeated independently and fully confirmed by Mrs. Huggins.

These comparisons can be successfully imitated in the laboratory by directing a spectroscope of sufficient power to the line of lead which the nebular line is sufficiently near, the slit being narrow, and the electrodes of lead near each other; and then causing, with the necessary precautions, the light of burning magnesium to fall also upon the slit. The lead line will be seen to fall within the end of the band, and to form with it a double line.

It may be mentioned in this place that this line of lead, and the iron line at 4957 at the position of the second nebular line, can be conveniently used in the laboratory in any chemical research on the nature of the nebulæ. No terrestrial line which does not fall almost exactly at these positions in the spectrum can have any claim to further consideration.

(*To be continued.*)

### Paris.

**Academy of Sciences**, August 12.—M. Des Cloizeaux, President, in the chair.—Remarks in connection with the "Introduction à l'étude des Races humains," Part II., presented to the Academy by M. A. de Quatrefages. In this second part the author passes from the general questions touching the evolution of man to those touching the evolution of the human races, of which he reckons at least one hundred and seventy-two, exclusive of minor varieties, all however reducible to the three fundamental black, yellow, and white stems. Adhering to the natural method of classification, as understood by Jussieu and Cuvier, he divides these stems into *branches* corresponding to primary and secondary divisions, under which come the *families* and *groups*. Much stress is laid on the early migrations of man, resulting in crossings of all sorts, and the general displacement of pure by half-caste races. The position of fossil man in the general scheme of classification is also studied, the five or six known varieties discovered in Europe being divided into two distinct branches allied to the white stock. Two distinct Quaternary types are also recognized in America, that of the Pampas affiliated to the Siberian, and that of the Lagoa Santa to the Eskimo branch of the yellow stock. Some bold speculations are indulged in regarding the primæval homes of the three fundamental groups and their subsequent dispersion from common centres over the face of the globe. In this scheme the north of Asia is considered the cradle of mankind, whose three primary divisions grouped themselves round the great central tableland, whence they gradually spread over the continents during Tertiary and Quaternary times. In the Oceanic world the Eastern Polynesians are affiliated to the white, the Melanesians (Papuans) to the black, and the Malays to the yellow stock, each division migrating from the mainland in the order already indicated by Prof. Keane ("Indo-Chinese and Inter-Oceanic Races and Languages"). The work is illustrated with 441 figures inserted in the text, four plates, and seven maps.—On a general law of induction in circuits devoid of resistance, by M. G. Lippmann. In this study the author proceeds exactly as in rational mechanics, where the fundamental laws are established, apart from the disturbing element of friction, which is afterwards considered as a particular force. He seeks the most general law of induction by assuming resistance to be null, and justifies this procedure *a posteriori* by the simplicity of the results, by their easy application and agreement with recent experiments.—On the vascular apparatus in animals and plants, studied comparatively by the surgical and thermochemical methods, by M. Sappey. In previous communications the author showed that in the vertebrates the thermochemical method is not only useful but preferable to the older process for the study of certain organs, especially the harder parts. In the present paper he directs attention to the structure of the vascular apparatus in plants and animals studied both by the surgical and thermochemical methods. The latter process is shown to yield as complete, accurate, and satisfactory results as could be desired; it is unquestionably superior to the former in the analysis of the veins and arteries of animals, and of the woody and other vessels of plants.—The virus of diphtheria, by M. C. H. H. Spronck. The author communicates the results of the researches on human diphtheria made by him, jointly with MM. Winglens, Van den Brink, and Van Herwerden, in Utrecht. The disorder is studied chiefly in connection with its action on the region of the kidneys.

These researches seem to leave no doubt that the bacillus of Klebs is the real active principle in diphtheria.—On the rotatory polarization of quartz, by M. H. Le Chatelier. Having already shown (*Comptes rendus*, May 20, 1889) that towards 570° C. the dimensions of quartz undergo a rapid increase, if not an absolutely sudden change such as that noticed in dimorphic transformations, the author here endeavours to place beyond doubt this sudden change by resuming the study of the rotatory polarization of quartz already begun by M. Joubert. From his investigations it seems evident that at the specified temperature this body really undergoes a sudden allotropic transformation while retaining under both states its rotatory power as well as its crystalline symmetry.—On the production of crystallized cobaltous and ferrous hydrates, by M. A. de Schulten. The author has obtained these hydrates in the crystallized state by using the same method that has enabled him to prepare artificial brucite and pyrochroite, as explained in the *Comptes rendus*, ci. p. 72, and cv. p. 1265.—Papers were contributed by M. C. Patein, on a source of error in the search for, and quantitative analysis of, albuminoid substances in the animal organism; by M. Maupas, on the agamous multiplication of some rotifers and other lower Infusoria; and by M. Th. Moureaux, on the cause of certain disturbances in the curves of the magnetographs.

### BERLIN.

**Physiological Society**, July 26.—Prof. Munk, President, in the chair.—Prof. Zuntz spoke on heat-regulation in man, basing his remarks on experiments made by Dr. Loewy. The store of heat in the human body at any one time is very large, equal in fact to nearly all the heat produced by the body during twenty hours, hence the heat given off to a calorimeter during a given period cannot be taken as a measure of the heat-production; this determination must be based rather upon the amount of oxygen consumed, and of carbonic acid gas given off. The purpose of the experiments was to ascertain what alteration the gaseous interchange of the body undergoes by the application of cold, inasmuch as existing data on this point are largely contradictory. The observations were made on a number of men whose respiratory gases were compared, during complete rest, when they were at one time clothed, at another time naked, at temperatures from 12° to 15° C., and in warm and cold baths. Each experiment lasted from half an hour to an hour, during which period the gases were repeatedly analyzed. As the result of fifty-five experiments, twenty showed no alteration of oxygen consumption as the result of cooling, nine gave a lessened consumption, while the remaining twenty-six showed an increased using up of oxygen. This diversity of result is explicable on the basis of observations made by Prof. Zuntz, who was himself experimented upon, as to his subjective heat-sensations during the experiments. He found that after the first impression due to the application of cold is overcome, it was quite easy to maintain himself in a perfectly passive condition; subsequently it required a distinct effort of the will to refrain from shivering and throwing the muscles into activity, and finally even this became no longer possible, and involuntary shivering and muscular contraction supervened, as soon as the body-temperature (*in ano*) had fallen $\frac{1}{2}$° to 1° C. During the first stage of cooling, Zuntz's oxygen consumption showed a uniform diminution; during the period also in which shivering was repressed by an effort of the will, cooling led to no increased consumption of oxygen, but as soon as shivering became involuntary there was at once an increased using up of oxygen and excretion of carbonic acid. This explains the differences in the results of Dr. Loewy's experiments, and may be taken to show that in man, and presumably in all *large* animals, heat-regulation as directly dependent upon alteration (fall) in temperature of the surrounding medium does not exist; the increased heat-production is rather the outcome of the movements resulting from the application of cold to the body. In *small* animals, on the other hand, there undoubtedly exists a heat-regulation dependent upon an increased activity of chemical changes in the tissues set up by the application of cold to the surface of the body, and in this case the thermotaxic centres in the brain most probably play some part.—Dr. Herter gave an account of experiments made by Dr. Popoff on the artificial digestion of various and variously cooked meats. Lean beef and the flesh of eels and flounders were digested in artificial gastric juice; the amount of raw flesh thus peptonized was in all cases greater than that of cooked meat similarly treated. The flesh was shredded and heated by steam to 100° C. The result was the same for beef as for fish. When compared with each other, beef was on the whole the most digestible, but the amount of fish-flesh which was peptonized was sufficiently great to do away with the evil repute which fish still has in Germany as a proteid food. Smoked meat differed in no essential extent from raw meat as regards its digestibility.—Dr. Cowl described his experiments on the mechanical latent period of a muscle. The muscle was hung up by one end, and its movements were recorded by a lever passing through the middle of the muscle, and writing on a spring-myograph. When both electrodes (using a "breaking" induction shock) were applied to the half of the muscle above the lever, the curve obtained showed a short latent period, after which it rose above the base-line. When the electrodes were applied below the lever, the same latent period was observed, after which the curve first fell slightly below, and then rose above the base-line. When one electrode was applied above and the other below the lever, then the elongation of the muscle was now present, now absent; in the latter case the length of the latent period was equal to the latency plus the duration of the visible elongation. From this it follows that the elongation of the muscle accounts for part of the latent period.

## BOOKS, PAMPHLETS, and SERIALS RECEIVED.

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